



Comparison of 316 (1.4401) and 316L(1.4404/1.4432) to 316Ti (1.4571) Stainless Steel Grades

Type '316Ti' stainless steel has been traditionally specified by German engineers and users with the Werkstoff number 1.4571. The former steel grade in the UK was 320S31.

This grade, 1.4571 (316Ti/320S31), is essentially a standard carbon 316 type with titanium stabilisation and is similar in principle to the titanium stabilisation of the 304 (1.4301) type to produce 321 (1.4541).

The addition of titanium is made to reduce the risk of intercrystalline corrosion following heating in the temperature range 425-815 °C. Here titanium carbo-nitrides are formed in preference to chromium carbides which has the effect of maintaining the correct distribution of chromium throughout the structure of the steel.

The result is that areas adjacent to grain boundaries, where the carbo-nitrides form, is not depleted of chromium to a level at which localised corrosion can occur in the grain boundary area (Intercrystalline corrosion or "ICC", also known in the past as 'weld decay').

The alternative approach to reducing the risk of ICC attack is to reduce the carbon level to levels below 0.03%. In this way a grade of 316 is produced with, in practice, the same resistance to ICC as 1.4571 (316Ti/320S31).

This is the basis of the 316L types (1.4404/316S11 and 1.4432/316S13).

Under most conditions it can be taken that the two grades are interchangeable, 1.4404 (316L / 316S11) being suitable for applications where 1.4571 (316Ti / 320S31) is specified. In aqueous corrosion media or environments at ambient temperatures, there is no practical advantage in specifying the 1.4571 (316Ti / 320S31) type in preference to 1.4404 or 1.4432 (316L/316S11/316S13). In some circumstances the 316L (1.4404 / 1.4432) grades may be better choices.

The presence of titanium to 1.4571 does, however, give some improvements to mechanical strength, especially, at elevated temperatures above about 600 °C. and care must therefore be exercised in selecting 1.4404 as a substitute under these conditions. The 1.4571 at ambient temperatures may however have inferior impact properties and may not cold form or cold head as readily as the 1.4404 / 1.4432 types. The machinability of 1.4571 can also be an issue as the titanium carbo-nitrides particles can result in higher tool wear.

The titanium carbo-nitrides in 1.4571 can also result in problems where high standards of polished surface finish are required. The titanium carbo-nitrides particles can result in 'comet-tail' streaks on the polished surface as they are dragged out during polishing.

This is similar to the 1.4541(321) grade, which was not recommended for a 'No8' bright mechanical polish in now obsolete BS1449 Pt2 (now replaced by BSEN 10088:2-1995 finish 1P/2P).

There is also some evidence that the 1.4571 type may have inferior pitting and stress corrosion cracking resistance, compared to the 1.4404 / 1.4432 types, although the general corrosion resistance can be assumed to be generally similar. The titanium stabilised 1.4571 grade may also be prone to 'knife line attack' in the heat-affected zones of welds, very close to the fusion zone where the carbo-nitrides have redissolved in the solid steel matrix.

The weldability of the 1.4571 and 1.4404 / 1.4432 can be assumed to be similar. Neither of the grades can be expected to weld 'easier' or 'better' than-the-other. Niobium stabilised fillers (welding consumables) should be used for welding the 1.4571, especially where elevated temperature weld strength may be important. In other circumstances a '316L' filler should give a matching weld metal aqueous corrosion resistance to that of the 'parent' 1.4571 '316Ti' material.

This Information Sheet is based on a draft supplied by Avesta Sheffield Ltd.